Mobile Robot Worksystem (ROSIE)

Developer: Carnegie Mellon University
Contract Number: DE-AC21-92MC29104
Crosscutting Area: Robotics

Deactivation & Decommissioning FOCUS AREA

Problem:

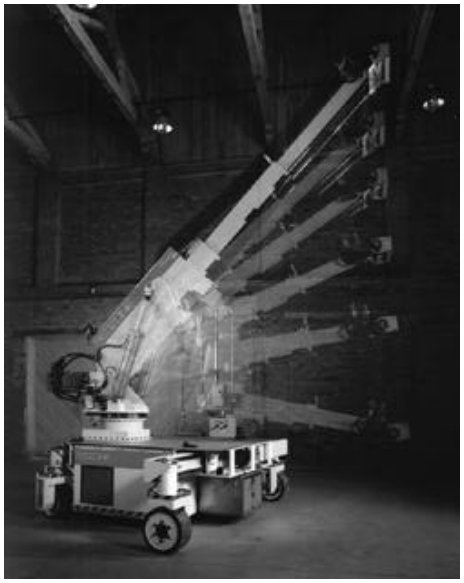
Work tasks for transitioning of Department of Energy (DOE) facilities include equipment disassembly and dismantling; size reduction, packaging and removal of materials; decontamination of structures and building surfaces; and sensor surveys and mapping to assure reduction of contamination and regulatory compliance. To maintain "as low as reasonably achievable" (ALARA) standards and minimize worker exposure to radiation and other hazards, these tasks have to be performed with robots and other remote equipment to the maximum extent possible. To achieve acceptable levels of productivity and lowest possible cost, the robots need to model their environment so that automatic control techniques can be used to improve performance.

Solution:

In Phase I an existing teleoperated worksystem (the Remote Work Vehicle, originally developed for accident recovery at Three Mile Island) was upgraded with contemporary computer controllers and tested in mock-ups representative of DOE facilities requiring deactivation and decommissioning (D&D). Using the results from Phase I, a next generation mobile worksystem, "Rosie", was designed and implemented to deploy tooling for selective equipment removal and other D&D tasks. In addition, a semi-automatic robotic perception system, called "Artisan", was developed to analyze and generate a geometric model of the worksystem's surroundings. Rosie provides the capability to do remote work in a variety of D&D applications while Artisan provides capabilities that help Rosie operators perform tasks faster and safer.

Benefits:

- Remote capabilities to operate tools, manipulate and package contaminated objects, and position sensors



- Dexterity combined with high strength throughout a large work volume

- Mobility to make the worksystem self-deploying and increase the work envelope beyond that of a fixed base

- Power and signal tether provides reliable communications and allows unlimited work duration

- Computer control for precise positioning, motion coordination, and status monitoring

- Workspace geometry modeling to enhance remote viewing, improve robot control, and improve speed of task execution

Technology:

The most important attribute of the Rosie mobile worksystem is its ability to address a variety of relevant D&D problems. Rosie will deploy Oak Ridge National Laboratory's (ORNL's) Dual Arm Work Module (DAWM) as its primary payload and use a variety of tooling for dismantlement operations. Tools currently envisaged include pipe shears, impact wrenches, and grippers for dismantlement; CO_2 blasters, coating sprayers and laser ablation systems for decontamination; scabblers for

concrete surfacing; and grapplers for moving heavy objects. The DAWM and other tools will be deployed by a high-reach telescoping boom capable of positioning 2000 lbs throughout a large work envelope. The boom is mounted on an omni-directional wheeled locomotor, a configuration that is well-matched to the primarily flat floor world of DOE facilities.

Rosie is designed like a piece of construction equipment; it can withstand the rigors of heavy work over periods of years. Though initial worksystem and tooling configurations will address a wide variety of tasks, the design incorporates spare conductors, power, and controls for the addition of tooling to meet future challenges. Likewise its control system is adaptable to accommodate system changes and upgrades.

Robotic task performance can be improved if the geometry of the work area is known. However, blueprints and as-built drawings of most facilities do not exist. Artisan uses laser rangefinder technology to generate a geometric description of objects in the robot's workspace exactly as they are found. This data can then be input to planning algorithms that sequence robot motions and enforce safeguards such as avoiding collisions. From the same information, a single display of the worksystem and the objects in its surroundings is generated, which the operator can view from any perspective. The display also provides a means for human/robot interaction through which the worksystem can be commanded.

The combination of workspace modeling and telerobotic control allow the operator to focus on task objectives rather than the details of remote equipment operation. Motion coordination, execution of trivial and low-risk actions and monitoring of system status are instead relegated to the computer control system with a net result of faster, safer task execution.

Rosie will be commercialized by RedZone Robotics in its product line of robot systems for hazardous duty.

Project Conclusion:

This project was completed in October 1996. The mobile worksystem Rosie provides all the necessary locomotion, heavy lifting and tooling deployment capabilities to perform D&D tasks remotely. The system is designed to use a wide variety of tools ranging from hand-held devices to large demolition and decontamination equipment utilizing surplus hydraulic power, electrical capacity and control channels.

Rosie is an electrohydraulic omni-directional locomotor with a four degree of freedom heavy manipulator mounted on its deck. The manipulator has a capacity of 2000 lbs throughout a work envelope that extends from 0 to 27 feet above floor level. Rosie's coordinated controls, ergonomic user interface, and modular design simplify installation and operation of the worksystem.

CMU has also developed Artisan, a perception system that combines range sensors and object analysis software to create a 3-D model of the robot's work area in situ (i.e, as it is discovered by the robot). Based on this work, another system was built and delivered to Argonne National Laboratory (ANL) for CP-5 D&D work under D&D Focus Area Sponsorship.

Contacts:

This project is a collaboration of Carnegie Mellon University's Robotics Institute and RedZone Robotics, Inc. Both organizations are distinguished for their abilities and records of integrating complex robot technologies into systems that prove themselves in both research and real world contexts. For information on this project, the contractor contact is:

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